

**ENGINEERS REPORT
on the
THOMAS POWER INCIDENT**

By:

Kenneth J. Kutchek, P.E.

March 16, 2020

Robson Forensic THE EXPERTS

THOMAS POWER INCIDENT

ENGINEERS REPORT

A. INTRODUCTION

On June 20, 2015, Thomas Power was utilizing his Hewlett Packard notebook computer while sitting in the lobby area of 24 Hour Fitness located at 101 Corbett Court, Pittsburgh, PA. Thomas Power was injured when the notebook battery exploded.

The purpose of my investigation was to determine the cause of the battery explosion and fire.

B. AVAILABLE INFORMATION

1. Complaint
2. HP Responses to Interrogatories
3. HP Responses to First Request For Production
4. HP Responses to Second Request For Production
5. HP Production 0001-5238
6. Deposition Transcript of Thomas Power dated July 30, 2018
7. Deposition Transcript of David Piph HP designee dated November 26, 2018
8. Deposition Transcript of John Wozniak dated July 18, 2019
9. 24 Hour Fitness security system video
10. Computer photos by others dated August 24, 2016
11. Computer visual inspection on December 24, 2019
12. Review of computer Xray results
13. Review of notebook computer scan results

C. BACKGROUND

Thomas Power [Power] purchased a Hewlett Packard [HP] EliteBook model 8730W notebook computer [computer] used on eBay. Power was utilizing his computer, on his lap while sitting in the lobby area of 24 Hour Fitness. The computer power adaptor was plugged into a 120VAC receptacle. Without notice the computer battery exploded and caught on fire.

Photo 1 – HP notebook computer post incident



D. DEPOSITION TRANSCRIPT OF THOMAS POWER DATED JULY 30, 2018

Power stated that he bought the HP notebook computer used on eBay in April 2013. Pg. 31. Power had the same type notebook computer prior to this subject notebook computer "the reason I bought it was because I already had one just like it, so I bought a duplicate" Pg. 34

Power stated that he received the power adaptor with the notebook but did not receive any HP paperwork. Pg 41. The notebook was shipped in a cushioned shipping box, "It was a regular notebook shipping container." Pg 41.

Power acknowledged that he used the notebook for more than two years before this incident occurred. Pg 40.

Power stated that he never had the notebook repaired prior to the incident. Pg 34 "No, it worked fine." Pg 45. He never replaced any parts and he never replaced the battery pack. Pg. 34 He never replaced the power adaptor. Pg 45

Power stated that he used the notebook for "somewhere between 20 and 60 minutes." "I was searching for a new apartment" at Club Julian on the day of incident. Pg.54 "they have guest WiFi there" Pg 55. Power stated that the notebook was plugged in to a 120vac outlet, "I always plugged it in" Pg 56. Power stated that the notebook was located on his lap. "I was wearing sandals, shorts and a polo shirt" The notebook was on his bare legs "most of it was on my skin." Pg 58.

Power stated that the notebook exploded, "suddenly and without warning it exploded into flame", "I jumped up and pushed it off of me and stepped back, it then exploded a second time." "Then the clerk came out with the fire extinguisher, while he was putting it out, it exploded a third time." "And at that point, I looked down at my legs and seen I was pretty badly burned." Pg 59 "It was coming from the under side of the notebook." Pg 61.

Power stated that he did not notice that the notebook was getting hot, he did not hear anything, see anything or smell anything unusual prior to the incident. Pg 59.

Power stated that there was no warning messages or anything on the computer itself before the first explosion, "nothing whatsoever". Pg 61

E. DEPOSITION TRANSCRIPT OF DAVID PIPHO DATED NOVEMBER 26, 2018

Pipho stated that he is employed by HP as an electrical hardware reliability engineer. "primarily supporting various customer escalations from an electrical, hardware, debug standpoint." Pg. 18

Pipho stated that the HP 8730 EliteBook uses lithium ion battery. Pg. 22 Pipho stated that the HP 8730 EliteBook battery pack, is designed and manufactured by STL Technology Pg 36. and the battery cells are manufactured by Sony. Pg. 28 STL Technology tests the battery pack. Pg 36.

Pipho stated that the battery pack in Power's notebook at the time of the incident was not an HP product. "based on the photographs, the markings for the labels are not HP. The serial number listed is not a valid HP serial number. And the paper label has no HP markings and is not consistent with the format of HP labels." Pg. 28

Pipho stated that the" battery pack controller is responsible for monitoring the current that is either going in or coming out of the battery pack and charged or discharged." "It is located on a small PCB board inside of the battery pack case." Pg. 47

Pipho stated that the power adapter is manufactured by HIPRO. Pg. 59 "there's three pins for power, ground and what is called adapter ID." "pin one is the adapter ID, pin two would be power, pin three would be ground." "the ID pin is used to identify the available wattage of the AC adapter as well as to regulate current and throttling in the notebook." "The ID pin could be considered a smart pin." Pg. 66 "the imbedded controller in the notebook would utilize the adapter signal primarily to identify the wattage of the AC adapter, ensuring that it is within the appropriate range. That's for that particular notebook design." Pg 74 "the same signal would be used as the notebook is operating. It would regulate throttling of the CPU to ensure that the notebook stays within the rating of the adapter." Pg 74

Pipho stated that "firmware that is programmed into the battery controller that is inside the battery pack." Pg. 80 "controls the necessary regulation of charge and/or safety aspects of the battery." Pg. 81

Pipho stated that "the notebook does regulate charging or not charging based on temperature reported by the battery." "there is a single battery temperature that is reported by the battery controller to the embedded controller in the notebook. If that goes above a threshold, then the charging will be discontinued." Pg. 89 The battery pack acceptable range of temperature is 0°C to 45°C for charging. "The embedded controller inside the notebook computer will tell the charger controller to not allow charging.", "it does not allow any charging above 45 degrees." Pg. 89 "the EliteBook 8730w shipped with a battery pack which contains design features to

monitor and control temperature, voltage and current to ensure the lithium ion battery cells charge and discharge within safe ranges." Pg. 92

Pipho stated that the battery pack contained warning "label that states replace with HP spares" Pg 94

Pipho acknowledged that there are non-HP approved battery packs which can fit into the notebook, "yes, I am aware." Pg 107 "we design the notebook to interact specifically with HP approved battery packs." Pg 107

Pipho stated that the notebook battery controller communicates with the battery pack, "the temperature is reported ", "for a particular charge current and charge voltage" Pg 112

Pipho stated that the notebook battery controller controls the battery pack charging "the charging voltage and current has to be carefully controlled" "that controls the current and voltage to the battery pack" Pg 116

F. DEPOSITION TRANSCRIPT OF JOHN WOZNIAK DATED JULY 18, 2019

Wozniak stated that he was employed as a process engineer at Compact and HP.

"I qualified [battery] cells to be used in all HP Notebook products and I oversaw the battery pack development." Pg. 17

Wozniak stated that he was involved with the design of the HP EliteBook 8730W notebook charging system. Pg. 18

Wozniak stated that the notebook battery controller "that controls the charging function and that communicates with the battery pack." Pg.20

Wozniak stated that the battery pack has safety protections to prevent the battery pack from overcharging "the primary protection IC monitors the individual cells." "it monitors the overall use and if it exceeds a particular voltage limit then it shuts off the current Pg. 26 "the primary protection IC also protects against over charge, over discharging, short circuit .Pg. 29

Wozniak stated that internal short circuiting of the battery pack "would be a manufacturing defect", "there is no good way to protect against that" Pg. 30

Wozniak stated that thermal runaway "would be in a lithium ion cell", "when the temperature exceeds a certain limit inside the cell it generates its own combustible material, mainly oxygen, and then goes into a runaway condition " Pg. 31

Wozniak stated that the battery pack has protections against excessive temperatures inside the cells" Pg. 31 "each individual cell has a PTC which is a positive thermal coefficient device", "and it has a CID, which is a current interrupt device " "which are the two primary factors to help prevent thermal runaway" Pg. 32 "PTC is designed if the temperature of the cell exceeds a certain limit, which would be lower than a thermal runaway it opens up and prevents more energy from being put into that cell" "CID responds to pressure inside the cell and as heat can build up or other conditions within that cell can build up, it opens up that CID releases that pressure so that it doesn't go into thermal runaway" Pg. 34

Wozniak stated that the notebook user can not access information regarding the status of the temperature of each of the individual cells in the battery pack. The user could only access information regarding the charge level and amount of running time. Pg 40

Wozniak stated that the notebook charging system did not have safety protections to prevent or stop external short circuiting, "I don't believe there is anything" Pg. 45

Wozniak stated that the notebook charging system prevents over charging and "overcharging is the primary way to prevent a thermal runaway condition" Pg. 49

Wozniak stated that the notebook communicates with the battery pack "there is a two wire interface." Pg. 51 The "notebook asks for information and the battery gives it to it "Pg. 52

Wozniak stated that the notebook communicates to the user via a pop up message "if the battery has lost enough capacity over time that it would suggest to the user you should consider replacing the battery pack." Pg 52

Wozniak stated that the notebook does not notify the user if a non HP approved battery was installed into the notebook. Pg. 52

Wozniak stated that the notebook charging circuit is not easily replaced. "I'm sure there is no pin for pin replacement", "and these are tiny micron distances", "not something that you could do without magnification and a very steady hand" Pg. 62

G. COMPUTER INSPECTION

I visually inspected and photographed the HP notebook computer at Friday & Cox office on December 19, 2019.

Photo 2 – HP notebook computer top



Photo 3 – HP notebook computer opened



Photo 4 – HP notebook computer opened



Photo 5 – HP notebook computer bottom and battery cells



Photo 6 – HP notebook computer bottom and battery cells



Photo 7 – closeup of battery cells



Photo 8 –battery cell



Photo 9 –top of battery cell



Photo 10 – notebook power adaptor



Photo 11 – notebook power adaptor closeup



The notebook computer was X-rayed by XYLON International on May 23, 2019. I was provided the X-ray results for review and analysis.

The notebook computer was CT scanned by Exponent on approximately September 30, 2019. I was provided the CT scan results for review and analysis.

H. ANALYSIS

Notebook computer

Power stated that he had been using the notebook for approximately 20-60 minutes, with the notebook on his lap, with the power adaptor plugged into a receptacle.

The HP notebook utilized a battery pack which contained eight 18650 lithium ion cells.

The bottom back area where the battery pack is located experienced heat damage. The evidence shows that two of the eight battery cells have experienced thermal runaway and exploded and have expelled their contents.

Battery pack

Battery pack installed in Power's HP notebook was not an HP approved battery pack.

Pipho stated that the battery pack in Power's notebook at the time of the incident was not an HP product. "based on the photographs, the markings for the labels are not HP. The serial number listed is not a valid HP serial number. And the paper label has no HP markings and is not consistent with the format of HP labels." Pg. 28

Pipho stated that the HP 8730 EliteBook uses lithium ion battery. Pg. 22 and the battery cells are manufactured by Sony. Pg. 28

Visual exam of Power's notebook battery cells indicated that the battery cells do not appear to be Sony 18650 cells.

Wozniak stated that the battery pack has safety protections to prevent the battery pack from overcharging "the primary protection IC monitors the individual cells." "it monitors the overall use and if it exceeds a particular voltage limit then it shuts off the current Pg. 26 "the primary protection IC also protects against over charge, over discharging, short circuit .Pg. 29

Wozniak stated that the battery pack has protections against excessive temperatures inside the cells" Pg. 31 "each individual cell has a PTC which is a positive thermal coefficient device", "and it has a CID, which is a current interrupt device " "which are the two primary factors to help prevent thermal runaway" Pg. 32 "PTC is designed if the temperature of the cell exceeds a certain limit, which would be lower than a thermal runaway it opens up and prevents more energy from being put into that cell" "CID responds to pressure inside the cell and as heat can build up or other conditions within that cell can build up, it opens up that CID releases that pressure so that it doesn't go into thermal runaway" Pg. 34

HP power adaptor

Power received the power adapter with the PH notebook computer when he purchased the notebook.

Power's notebook power adapter appears to be manufactured by HP.

Pipho stated that the power adapter is manufactured by HIPRO. Pg. 59 "there's three pins for power, ground and what is called adapter ID." "pin one is the adapter ID, pin two would be power, pin three would be ground." "the ID pin is used to identify the available wattage of the AC adapter as well as to regulate current and throttling in the notebook." "The ID pin could be considered a smart pin." Pg. 66 "the imbedded controller in the notebook would utilize the adapter signal primarily to identify the wattage of the AC adapter, ensuring that it is within the appropriate range." Pg 74

HP notebook battery charge controller

The HP notebook battery controller communicates with the battery pack. Wozniak stated that the notebook communicates with the battery pack "there is a two wire interface." Pg. 51 The "notebook asks for information and the battery gives it to it" Pg. 52 Wozniak stated that the notebook communicates to the user via a pop up message "if the battery has lost enough capacity over time that it would suggest to the user you should consider replacing the battery pack." Pg 52

Pipho stated that the notebook battery controller controls the battery pack charging "the charging voltage and current has to be carefully controlled" Pg 116 Wozniak stated that the notebook charging system prevents over charging and "overcharging is the primary way to prevent a thermal runaway condition" Pg. 49

Wozniak stated that the notebook charging system did not have safety protections to prevent or stop external short circuiting Pg. 45 nor internal short circuiting of the battery pack "there is no good way to protect against that" Pg. 30

There was little to no communication to the user about the battery pack.

Wozniak stated that the notebook user can not access information regarding the status of the battery pack temperature. The user could only access information regarding the charge level and amount of running time. Pg 40 Power stated that there was no warning messages or anything on the computer itself before the first explosion, "nothing whatsoever". Pg 61

Repairs or modifications

Power stated that he never had the notebook repaired. Pg 34 "No, it worked fine." Pg 45. He never replaced any parts including the battery pack Pg. 34 and the power adaptor. Pg 45

Wozniak stated that the notebook battery controller circuit is not easily replaced. "I'm sure there is no pin for pin replacement", "and these are tiny micron distances", "not something that you could do without magnification and a very steady hand" Pg. 62

There was no evidence that indicated that the HP notebook battery controller circuit had been replaced.

HP Battery Pack Authentication

HP was aware that non-HP approved battery packs were available for sale by third party retailers. Piphon acknowledged that there are non HP approved battery packs which can fit into the notebook, "yes, I am aware." Pg 107 "we design the notebook to interact specifically with HP approved battery packs." Pg 107

HP was aware of the potential hazard of using non-HP approved battery packs and provided a warning on the battery pack to replace with an authentic HP battery pack. Piphon stated that the battery pack contained warning "label that states replace with HP spares" Pg 94

HP was aware of authentication technology for replaceable components such as batteries. HP used the authentication technology in their ink jet printers. HP holds patent US20110109938A1 "Authenticating a Replaceable Printer Component", with an application

date of May 29, 2008 and with an issue date of May 12, 2011. HP's patent relates to ink cartridge authentication in ink jet printers.

Authentication technology was available at the time. Authentication is the process to verify the origin, identity and legitimacy of a replaceable item. Multiple authentication patents existed for electronic products.

Panasonic held a patent which relates to battery authentication in notebook computers. Panasonic patent US20100017610A1 - "Authentication System" with an application date of September 28, 2009 and with an issue date of March 6, 2012.

BlackBerry held a patent which relates to battery authentication in mobile phones. BlackBerry patent US20120046015A1 - "Battery Pack Authentication for a Mobile Communication Device", with an application date of October 28, 20011 and with an issue date of January 28, 2014.

Lexmark International held patents which relate to ink cartridge authentication in ink jet printers. Lexmark International holds patent US20050206672A1 - "Method of Authenticating a Consumable", with an application date of May 18, 2005 and with an issue date of September 22, 2005 and patent US7585043B2 - "Method of Authenticating a Consumable", with an application date of May 18, 2005 and with an issue date of September 8, 2009.

The HP notebook did not authenticate the installed battery by detecting, verifying and ensuring the use of only HP approved battery packs. HP failed to authenticate the installed battery and prevent the use of non-HP approved battery packs.

The HP notebook did not warn users that a non-authentic, non-HP approved, battery pack was installed. Wozniak stated that the notebook does not notify the user if a non HP approved battery pack was installed into the notebook. Pg. 52. HP failed to warn users if a non-HP approved battery pack was installed.

The HP notebook did not have interlocks to prevent the use of non-authentic, non-HP approved battery pack. HP failed to prevent the use of non-authentic, non-HP approved battery packs.

I. FINDINGS

Within the bounds of reasonable engineering certainty, and based on my training, education and experience and subject to change if additional information becomes available, it is my professional opinion that:

1. HP was aware that non-HP approved battery packs were available for sale by third party retailers which could fit into their HP notebooks.
2. HP ensured that its approved battery packs contained various safety protections and underwent various levels of testing and quality control.
3. HP could not ensure any safety protections, testing and quality control for non approved battery packs. This created a risk for its notebook users.
4. HP was aware of the potential safety hazard of using non-HP approved battery packs in their HP notebooks and warned users against it. Power was exposed to this hazard.
5. This combination of hazard and risk created an unreasonably dangerous condition. Power's exposure to this dangerous condition was a cause of his injury.
6. HP failed to authenticate battery packs installed in its notebook computers.
7. HP failed to inform or warn the user of a non-HP approved battery pack installed in its notebook computers.
8. HP failed to have interlocks to prevent the use of non-HP approved battery pack in its notebook computers.
9. Had HP prevented the use of non-HP approved battery packs, this incident would have been prevented.



Kenneth Kutcheck PE, CFEI